

SPECIFICATION:

TITLE OF INVENTION

Truck Alignment System

CROSS-REFERENCE TO RELATED APPLICATIONS

References Cited UNITED STATES PATENT

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1,804,448	5/12/1931	Whitener	
2,475,502	7/5/1949	Holes	248--201
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2,616,186	11/4/1952	Shooter	33--203.17
3,810,313	5/14/1974	Hicks	33--288
4,167,816	9/18/1979	Barman	33--203.12
4,302,104	11/24/1981	Hunter	356-152
4,330,945	5/25/1982	Eke	33--288
4,338,027	7/6/1982	Eke	356--155
4,377,038	3/22/1983	Raglan	33--203.18
4,337,581	7/6/1982	Eke	33-288
4,413,420	11/8/1983	Hoffman	33-180
4,433,489	2/28/1984	Bryce	33--203.18
4,441,259	4/10/1984	Letterman	33--288
4,569,140	2/11/1986	Hobos	33-203.18
4,630,379	12/23/1986	Wickmann	33-288
4,718,759	1/12/1988	Butler	356--152
4,726,122	2/23/1988	Anderson	33--288
4,815,216	3/28/1989	Swain	33--203.18
4,856,199	8/15/1989	Merrill	33--203.17
4,899,457	2/13/1990	Ferrous	33--608
4,939,848	7/10/1990	Armstrong	33--608
5,044,090	9/3/1991	Hunter	33-760
5,125,164	6/30/1992	Mourner	33-608
5,177,558	1/5/1993	Hill	356--152
5,179,784	1/19/1993	Chows	33--203.18
5,443,537	8/22/1995	Huskiness	33--193
5,625,953	5/6/1997	Heady	33--203.18
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5,987,761	11/23/1999	Ohnesorge	33--203.18
6,021,576	2/8/2000	Campbell	33--203.21

6,349,593	2/26/2002	Blair	73--146
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6,823,598	11/30/2004	Lester	33--286

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

REFERENCE TO SEQUENCE LISTING, A TABLE OR A COMPUTER PROGRAM

LISTING COMPACT DISK APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

001 This invention relates to the use of an apparatus attached to each wheel of a vehicle. The units are light weight and portable so they may be used in the shop or in the field. The system checks buses, trucks and trailers for their geometric alignment of the suspension system, including the various critical parameters. The trammel is used in a different manner than the Prior Art items listed below:

002 This invention is for the alignment of Class 8 Trucks, Trailers and Buses. It is standard procedure in the industry to align the steering axle and the drive axles. This should be accomplished periodically depending on the condition of the tires and certain wear patterns, or if you encounter pulling to either side or vibration.

003 If you are driving a truck or bus with it being out of geometric configuration, you should have the vehicle aligned so you will not wear the tires excessively, and it is more difficult to steer and to control, which is a safety factor to consider. Therefore, some of the units previously and currently being used, use the tires as a basis of the alignment. Even if tires are inflated equally, the profile will not be exactly the same. When you use the tires as a reference point, you will not achieve an accurate reading as using the wheels.

004 Estimates have shown that not only does misalignment cause tire wear, but also there is up to twenty-five percent (25%) loss in fuel economy. This fuel loss is a result of the grinding action that exists between the tire and the road. Misalignment also causes increased rolling resistance, and increased wear to the suspension system components also heighten the fatigue level for the driver due to continuously fighting the steering wheel.

005 Correct front and rear alignment on heavy-duty Class 8 Trucks result in a straight-in-line thrust action of the vehicle. If the front axle is perpendicular to the frame, but the rear tandem axles are out of alignment, this will result in an off-center thrust, which will cause excess tire scrub on both the front and rear tires. Consequently, forcing the driver to turn the steering wheel to off-set the thrust, compensating for the opposing tire force.

006 If the front wheels would push the steering wheel to the left, and as the driver attempted to correct this condition, the tires would be forced into a side-scrub condition. Detailed tests have shown that under such a condition ($1/4$ degree), tire scrub equals to 11.5 feet per mile. This means the front tire will slide sideways, or scrub 218 miles for every 100,000 miles traveled.

007 This invention relates to the use of the trammel points and three different lengths of rods. The two shortest rods are used to check the frame of a truck or trailer. The axles must be perpendicular to the frame rails, and the frame rails must be centered on the axles. To achieve this, you use the apparatus, and the trammel rod, with pointer, on the drive axles and trailer axles' apparatus to the frame rail.

008 An object of this invention is the use of the trammel rod, with points, on the steering axle apparatus to set the toe-in. Using the longest rod and placing the pointer in the indentation in front of both steering axle wheels and setting it to the same number indentation back of the wheels, will give you a preset dimension for the correct toe-in.

009 An essential feature of this invention is the scale attached to the steering axle apparatus. The use and attachment of the laser beam light to the drive axle apparatus giving optical measuring precision. "Prior Art" use of the laser beam light depicted in paragraph 012

is different than the way we use it. Different location, attachment and tooling.

010 Another object we designed is a Jig to be used to calibrate the apparatus.

You can not design tooling and not design a way to calibrate.

2. Description of the Prior Art

011 The trammel is used in many U.S. Patents as follows: U.S. Pat. No. 916,912, dated March 30, 1909 (Carrier); U.S. Pat. No. 2,532,376, dated Jan. 9, 1947 (Smith). The trammel was manufactured in some of the following patents: U.S. Pat. No. 1,804,448 dated May 12, 1931 (Whitener); U.S. Pat. No. 4,939,848, dated July 10, 1990 (Armstrong); U.S. Pat. No. 6,021,576, dated Feb. 8, 2000 Campbell; US Pat No. 4,413,420 dated Nov. 8, 1983 (Hoffman); U.S. Pat. No. 5,647,139, dated July 15, 1997 (Richardson); U.S. Pat. No. 6,021,596 dated Feb. 8, 2000 (Campbell). Many used with automobiles, U.S. Pat. No. 6,775,639, dated Aug. 10, 2004.

012 "Prior Art". The laser beam light is used in many U.S. Patents, as follows: U.S. Pat. No. 4,338,027, dated July 6, 1982; Eke used the laser light in a different way by installing it in a separate unit that sets in front of the truck or vehicle. It is too large to be a mobile unit. U.S. Pat. No. 5,125,164, dated June 30, 1992 (Mourner); U.S. Pat. No. 5,443,537, dated Aug. 22, 1995 (Huskins). They use the laser under the center of a truck and from the back to the target in the front, and then use the trammel to align the front drive axle. My invention uses the laser on all axles. Many laser units are used with automobiles as follows: U.S. Pat. No. 4,330,945, dated May 25, 1982 (Eke); U.S. Pat. No. 4,441,259, dated April 10, 1984 (Letterman); U.S. Pat. No. 4,726,122, dated Feb. 23, 1988 (Anderson); U.S. Pat. No. 5,125,164, dated June 30, 1992 (Mourner); U.S. Pat. No. 5,177,558, dated Jan. 5, 1993 (Hill).

013 Another object of this invention is the use of this apparatus, and its attachment to the wheel using our designed locator pin with a radius that rests in the rim of the wheel and threaded hold down rods. In this manner you have a better attachment and one that is more accurate. U.S. Pat. No. 4,377,038, dated March 22, 1983 (Rage). Rage uses three locate pins and use three fingers that attach to the tire. This wheel clamp only holds the aligning tool. U.S. Pat. No. 4,815,216, dated March 28, 1989 (Swain). Swain is also only a clamp to hold the alignment tool. U.S. Pat. No. 5,179,784, dated Jan. 19, 1993 (Chows). Chows unit does not do a complete alignment and is only held on by the use of a bungee cord.

014 Another object of this invention are the roller plates which are used under all wheels when making any adjustments on that axle so it will move without restriction. Under "Prior Art", there is a unit called front wheel turning gauge used by Mack Trucks, Inc. We have not found the patent, although we are familiar with this unit. This invention called for one larger and made different so it could be used on not only the steering axle wheels, but also the drive axle wheels and the trailer axle wheels. Under "Prior Art", a rolling plane used in U.S. Pat. No. 4,569,140, dated Feb. 11, 1986 (Hobos), has a completely different design and is used in a different manner.

U.S. Pat. No. 4,338,027, dated July 6, 1982 (Eke). Eke use large casters on their roller plates and this makes it different in the design and construction. U.S. Pat No. 4,167,816, dated Sept. 18, 1979 (Barman). Barman call their unit a rotatable turntable which only turns in a circle, not moving in all directions. It is similar to the one Mack trucks are using.

015 This present invention depicts an apparatus that is used to align trailers that you attach to the king-pin at the front and under the trailer and with the use of the drive axle aligning

apparatus, using the laser beam light to project a beam onto a scale, and using the same type of scale as the one used in Figure 3, Item #17, and Figure 4, Item #25, located on the side of the center support of the apparatus. This is accomplished in a different manner using a different type tooling, as others listed in the following "Prior Art", Alignment of trailers, U.S. Pat.

No.4,413,420, dated Nov. 8, 1983 (Hoffman). Hoffman calls out using flexible tapes to measure distance in their alignment. U.S. Pat. No. 4,569,140, dated Feb. 11, 1986 (Hobos). Hobos calls out the use of flexible types and elastic lines to be used in their alignment.

BRIEF SUMMARY OF THE INVENTION

016 The principle objects of the present invention are to provide an apparatus for alignment that will improve accuracy and be user friendly. Some of the alignment units previously and currently in use today work on the principle that the tire is the point of reference for the alignment, even if the tires are inflated equally, the profile will not be exactly the same. Therefore, if the tires are used as the point of reference, you will not get an accurate reading. This system uses the wheels as the point of reference.

017 Another object of this invention is to provide an improved apparatus that uses the laser beam light located on the drive axle apparatus in conjunction with the scale located on the steering axle apparatus, both being attached to the apparatus, and they are resting directly on the wheel.

018 Therefore, an object of this invention is to provide an improved apparatus that is placed under the wheels when adjusting for the alignment. Most manufacturers do not supply this equipment. The roller plates allow the wheels and axle to move freely in all directions with the weight of the truck when aligning.

019 Another object of this invention is to provide accuracy using the laser beam light located on the drive axle apparatus in conjunction with the scale located on the steering axle apparatus, Figure 3 and Figure 4, both being attached to and resting directly on the wheels instead of the tire.

020 Another object of this invention is to provide accuracy using the trammel rod with points instead of using a measuring type.

021 It is an object of this invention to provide tooling to calibrate the apparatus. You cannot design a device for measuring the geometric relationship of a vehicle and not be capable of the calibration of said unit.

022 It is further an object of this invention to provide an apparatus to measure the geometric and relationship of a trailer. This apparatus is attached to the king-pin with an extension downward on each side, and a scale, the same design as depicted in Figure 3 and Figure 4, located on the lower brace that receives the laser beam light when being aligned.

023 It is further again an object of this invention to provide a system that this could be accomplished without using any tape measuring or strings or anything that is not precise.

024 Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

025 Fig.1 is a perspective view showing the apparatus attached to a truck according to this invention. It depicts using roller plates and the apparatus which is attached to the wheels and the long trammel rod used to set the steering axle in toe-in, the short rod back of the drive axle wheel to check if the frame is centered on the axle.

026 Fig. 2. is a perspective view showing the second phase of this invention with the appropriate apparatus attached to a trailer that are required to accomplish the alignment.

027 Fig. 3 is a perspective exploded view showing one of four apparatus used for the alignment installed on the steering axle passenger side with the scale attached.

028 Fig. 4 is a perspective exploded view showing another apparatus used on the steering axle driver side which is opposite to the passenger side.

029 Fig. 5 is a perspective exploded view showing another apparatus used on the drive axle. passenger side with the laser beam light attached. This is one of the main objects.

030 Fig. 6 is a perspective exploded view showing the last of four apparatus used on the drive axle driver side which is opposite to the passenger side.

031 Fig. 7 through Fig. 11 is a perspective exploded view showing the roller plates as depicted in Fig. 1, Item 1 as an object in the invention.

032 Fig. 12 is a perspective exploded view showing the apparatus in Fig. 2, Item 11 used for aligning the trailer as stated in this invention.

033 Fig. 13 through Fig. 15 is a perspective exploded view of the trammel rod, with points, as being used in this invention. The word trammel and the basic design is "Prior Art", although our use of it is one of the objects in this invention.

034 Fig. 16 through Fig. 18 is a perspective exploded view of the locator pins we designed and manufactured and is incorporated in this present invention.

035 Fig. 19 and Fig. 20 is a perspective exploded view of the left and right scales we manufacture and depicted in Fig. 3 and Fig. 4 which are incorporated into this invention.

036 Fig. 21 is a perspective exploded view of the tooling we design to calibrate the

apparatus used for the alignment on the said vehicles.

037 Fig. 22 is a perspective exploded view of the hinge we designed, Item 40 depicted in Fig. 12.

DETAILED DESCRIPTION OF THE INVENTION

038 The invention relates to the alignment apparatus for indicating the angular relationship of the vehicle wheels, and more particularly, to a laser beam light alignment system. However, it is most important to correct or replace any parts that are not within the manufacturer's specifications, or of poor quality, or that are damaged in any way, due to wear or poor workmanship previously, before proceeding to the next step.

039 Referring to the drawing starting with Fig. 1 is a perspective drawing, view showing a truck in phantom to make it easier to see the function of said apparatus. At this time, jack the steering axle and rotate the wheel checking the bearings for their condition and tightness. If required, you must replace bearings or recalibrate. Checking the wheel movement, top to bottom, making sure the king pin and bushing are not worn. Move the wheel from side to side to see if you have any movement in the tie rod ends or drag link, and with a steel pry bar make sure the spring bushing in the front and rear of the spring are not worn excessively. Repeat on the other side. When everything checks out, you lower the wheels onto Item #1, the roller plates. See Fig. 7 through Fig. 11 for parts breakdown which are used to make up the complete apparatus using Item #27 and Item # 28, use when adjusting so the axle will move freely with the weight of the truck.

040 Fig. 1, Item #2 is an apparatus shown on the passenger side. Item #3 shown on the driver side is opposite. See Fig. 3 and Fig. 4 for parts breakdown on these units. Also, Item

#7, trammel rod with points, see Fig. 13 through Fig. 15 for parts breakdown Item # 7 shown resting on Items #2 and #3 Fig.1, There are indentations on the top of the bottom support Item 63, each end and numbered 1 through 4 shown in front as Item #22 with black background and back of the wheel shown driver side with black background. The back section, Item #23 are shown with red background, and these are pre-set indentation and when the rod is adjusted in front and moved to the back, and it aligns with the same number the toe-in is correctly set.

041 Fig. 1 Jack the rear drive axle and rotates the wheel and check the bearings for condition and tightness. Checking the break drums making sure they are not rubbing, or the brakes are not out of adjustment. It's important to check the wheel for movement, top to bottom and side to side, if required the bearings will need to be replaced or recalibrated. The other side needs to be checked also. When everything checks out, lower wheels onto roller plates, Item #1, Fig. 7 through Fig. 11 for parts breakdown as explained before.

042 In Fig. 1, you install Item #4, apparatus on the passenger side, Item #5 on the driver side which is opposite, see Fig. 5 and Fig. 6 for parts breakdown on these units. The bottom and lower front pins are fixed to locate unit, use the two threaded rods to hold the unit to the wheel. Rotate the other four pins to rest in wheel radius and tighten bolts. Using Item #6 Fig. 14, short trammel rod and the adjustable point only, rod is used on both sides as shown, one end touching the outside of the frame rail Fig. 1 and Fig. 2, and the other end with adjustable point resting in one of the indentations with red background on the top support, Item #66, setting it and then checking the same place on the other side. If not the same, you add or remove shims under the transverse rod bracket to the frame rail to center frame on axle. To accomplish the alignment, you turn on the laser light, Item #26 on both sides. The laser is installed on Item #65,

support which projects a light onto the scale located on the apparatus, Item #2 and Item #3, respectively. If they do not align on the same number, you will adjust the drive axle to align correctly. When completed, you will remove the apparatus and jack the truck and remove roller plates. If the vehicle has two drive axles then proceed to the forward drive axle and complete in the same manner.

043 Fig 2 is a perspective drawing showing a view of a trailer phantom to make it easier to see the function of said apparatus. You install the apparatus, Item #11, Fig. 12 for parts breakdown, under front section of trailer touching Item #36 to king pin, and swing the two adjustable legs, Item #35 backward and down resting them on the ground or floor to hold unit in place.

044 Fig. 2, jack the rear axle and rotate the wheel and checking the bearings for condition and tightness. Checking the brake drums making sure they are not rubbing or the brakes are not out of adjustment. Check to see if there is wheel movement, top to bottom or side to side. If so, you must replace bearings or recalibrate. Check the other side. When everything checks out, lower wheels onto roller plates, Item #1, see Fig. 7 through Fig. 11 for parts breakdown. They are the same units as used with the truck alignment, Fig. 1.

045 Fig 2 trailer, you install the apparatus, Item #4, right side and Item #5, left side, is opposite. See Fig. 5 and Fig. 6 for parts breakdown, used in the same way as on the truck. The bottom and lower front pins are fixed to locate unit, use the two threaded rods to hold the unit to the wheel. Rotate the other four pins to rest in wheel radius and tighten bolts. Using Item # 6, the trammel rod on both sides as shown, one end touching the outside of the frame rail and the other end with the adjustable point resting in one of the indentations Item # 66, with the red

background on the top of support #64, setting it and checking same place on the opposite side. If not the same, you correct as you did on the truck. To accomplish the alignment, you turn on the laser light, Item #26, on both sides, the laser installed on Item #65 support, the light will be project on the two scales. Item #17 and Item #25 is located on the scale support Item # 38, attached to the king pin tooling Fig. 12. If it is not the same number on both scales, the axle will be adjusted to align up correctly. After this jack and remove roller plates and the apparatus from the wheels. If you have two axles then proceed to forward axle and complete in the same manner.

046 Fig. 3 is a perspective exploded drawing for the apparatus used on the steering axle wheel of the passenger side for geometric alignment of the suspension, including the wheels, Item #2, manufactured using aluminum bar stock and welded together. The main body consists of a center upright support, Item #33, a top support, Item #62, and a bottom support, Item #63. A 7' scale support, Item # 37, locator pins, Item #13 with hole and steel insert in center for fixed locator pins, Item #14 with hole and steel insert is eccentric for aligning with the wheel, all use a chain which attach to the locator pins so they will not get lost or damaged, Item #15. Short J-hook used to hold apparatus onto wheel Item #16, with spring Item # 19, washers Item # 20 and wing nuts Item # 21, scale right hand, Item #17, allen bolt to attach locator pins to support, Item #18, indentation on bottom support for precise measuring Item #22 and Item #23, three hole group for 19.5", 22.5" and 24.5" size wheels, Item #24.

047 Fig. 4 is a perspective exploded drawing for apparatus used on the steering axle driver side wheel for geometric alignment of the suspension system, including the wheels. Manufactured using aluminum bar stock and welded together. Item #3, OPPOSITE SIDE FROM APPARATUS ITEM #2 except the following items: There are two places for the scales Item

25 located on Item # 3 left hand, Item # 17 located on Item # 2 right side.

048 Fig. 5 is a perspective exploded drawing for the apparatus used on the drive axle wheel passenger side for geometric alignment of the suspension, including the wheels. Item #4 manufactured using aluminum bar stock and welded together, consist of a upright center support, Item #33, a top support, Item #64, located twenty-five percent down from the top mark on the center support and a center support, Item #65, located fifty percent down from the top mark on the center support, a long J-hook Item # 9, used to hold apparatus onto wheel, using spring Item # 19, wing nut Item # 20, and washers Item # 21, locator pins Item #13, with hole and steel insert in center for fixed pins, Item #14 with hole and steel insert is eccentric for alignment with any wheel, Item # 15, a chain is attached to locator pins to hold them so they will not get lost or damaged, Item # 18, allen bolt to attach locator pins to support, Item # 24, three hole group for 19.5"-22.5" and 24.5" size wheels, Item #26, laser beam light, Item # 66, indentations with a red background, on top of support, item #64.

049 Fig. 6 is a perspective exploded drawing for the apparatus used on the drive axle wheel driver side for geometric alignment of the suspension, including the wheels. Manufactured using aluminum bar stock and welded together, Item # 33, consist of a center upright support, Item # 64 a top support, located twenty-five percent down from the top mark and Item # 65 a center support, located fifty percent down from the top mark, Item # 9 long J-hook used to hold apparatus onto wheel, Item # 19 spring, Item # 20 wing nut, Item # 21 washers, Item # 13 locator pin with hole and steel insert in center for fixed pins, Item # 14 locator pins with hole and steel insert eccentric for alignment with any wheels, Item # 18 allen bolt to attach locator pins to

support. Item #15 a chain to hold pins to keep them from getting lost or damage, Item # 24 three hole group for 19.5", 22.5" and 24.5" size wheels, Item # 26 laser beam light, Item # 66 three indentations with red background on the top of the top support Item #64.

050 Fig. 7 through Fig. 11 is depicted in this perspective exploded drawing for the apparatus used with the geometric alignment of the suspension system. Fig. 7 depicts Item #27 which is the bottom steel plate comprising of Fig. 10, Item #29, aluminum square block with a hole, Item #30 through the center, and Fig. 11, Item #32, "Prior Art", Ball Transfer 30 MAC is pressed into Item #30, and there are two holes, Item #31, one in opposite corners using two screws and nuts each, then attach nine units, Item #29 assembly to complete Item #27. Fig. 9 depicts a steel plate, Item #28, the same size as Item #27, and it lays on top of the steel balls and the two items, Item #27 and Item #28 comprise an apparatus called roller plate, which is depicted in Fig. 1 and Fig. 2 to be placed under the wheels when performing an alignment.

051 Fig 12 is a perspective exploded drawing for the apparatus used on the trailer for geometric alignment of the suspension, including wheels. Item #11 is manufactured using 4130 steel tubing. The top member, Item #34 has a support on each side extending down, and one on a 45 degree from the bottom, inward and upward to top member and are welded at the joints. At the bottom on each side there is a scale support Item # 38 also welded. On the support you will find a scale, Item #17 on the right side, and Item #25 on the left side where the laser beam light projects the position of the trailer axles onto when performing the alignment. Item #36, steel plate welded with a cut-out that rests against the king pin when installed on the trailer, the adjustable legs, Item #35 is held in place with the clip, Item #39 when not in use, side upright

member, Item #67, brace for the side upright, Item #68. For the alignment, you would lower legs and swing, then to the rear and down resting on the ground or floor. To calibrate this apparatus, you use the long trammel rod and points placing one point on the center of the top support. There is an indentation with a black background, and the other pointer on the 3" mark on the scale, and then swing to the other side 3" mark set that scale to the same setting, and this would be calibrated.

052 In starting the alignment, you first install the apparatus on the king pin while adjusting the two legs holding it in place. Jack the rear axle and rotate the wheels while checking the bearings for their condition and tightness. Check the brake drums making sure they are not rubbing, and the brakes are not out of adjustment, and check the wheel if there is any movement top to bottom or side to side. If so, you must replace the bearings or recalibrate. When everything checks out, you lower the wheels onto the roller plates.

053 Install the same apparatus on the trailer axle wheels as used on the drive axle wheels, locate using the lower and front fixed pins in wheel radius, rotate the other four pins as they are eccentric and will rest in the radius, use the J-hook to hold to wheel. Turn on the laser beam light, "Prior Art" Cen-Tech #46735, on both sides and light will be projected on the two scales located on the forward apparatus attached to the king pin. If not the same number on both sides, you must adjust the axle to align correctly. After this process, remove the apparatus and jack the axle and remove roller plates. If you have two axles, then proceed to forward axle and complete in the same manner.

054 Fig. 13 through Fig. 15 is a perspective drawing of a trammel rod with points assemble, "Prior Art" General Tools, Item #520, wherein we manufacture aluminum rods in three

lengths for this invention that use the trammel points. Item #6 assembly, using Item #42 rod, Item #44 fixed point, Item #45 adjustable point, Item #7 assembly, using Item #43 rod, Item #44 fixed point, Item #45 adjustable point, and Item #10 assembly, using Item #41 rod, Item #44 fixed point, Item #45 adjustable point, Item #44 fixed point that slides on rod for first setting. Item #45, adjustable point used for fine tuning.

055 Fig. 16 through Fig. 18 is a perspective exploded drawing for the apparatus used on all vehicles for geometric alignment of the suspension, including the wheels. Fig. 16 depicts one of our locator pins showing the one end that is machined with a shoulder and rounded end. We are using this end on all our locator pins to rest into the radius on the wheels. Fig. 17, Item #47 depicts the other end which is the same for all fixed pins Item #13, the hole and steel insert are in the center of the pin. Fig. 18, Item 48 depicts the other end which is the same for all eccentric pins Item #14 that has the hole and steel insert located off center. This is necessary for this to be eccentric and to be adjustable to fit all wheels.

056 Fig. 19 and Fig. 20, Item #17 depicts the scale manufactured for this invention, and you cannot purchase right hand scales anywhere. Fig. 20, Item #25 depicts the left hand scale that is manufactured as a set so they will be more accurate.

057 Fig. 21 is a perspective exploded drawing for the apparatus used to calibrate the apparatus depicted in Fig. 1, Item # 2 2 through Item # 5, and also depicted in Figs. 3 through Fig.6, Item #50, manufactured using aluminum plate stock, rectangular shape. The other item, Item #51 is a triangular shape with three legs, Item #53, and all welded together, Item #52 are two cut-outs for carrying the unit, Item #9 are the J-bolt used to hold the drive axle units onto the wheels wherein they are used here also. The apparatus is installed on this jig, using the laser beam

light onto the scale in the same manner, but to calibrate the units, you move the scale to line up correctly and tighten the screws.

058 Fig. 22 is a perspective exploded drawing used for the hinge assembly manufactured for this invention it is attached to Item 34, which is part of Item #11, Fig. 12. Fig. 22 depicts Item #40, and shows breakdown, Item # 12 which was machined from 75 ST aluminum round stock to fit into the tube Item # 35, and held in place with a bolt and nut, Item #60, the section remaining machined to fit into a u-channel Item #54 with the hole, Item #58, and this unit is held together with Item # 56 and Item # 57 at this point was attached to Item #34, using screw and nut, Item #55, through hole, Item #61. There are two Item # 40 required per unit. This hinge is required to move in two directions.

- END -